Asutosh Museum Series No. 2

MUSEUM METHOD

AND THE

PROCESS OF CLEANING AND PRESERVATION

BY

MINENDRA NATH BASU, M.Sc., P.R.S.

ASST. LECTURER IN ANTHROPOLOGY AND CHEMIST-IN-CHARGE, ASUTOSH MUSEUM LABORATORY, CALCUTTA UNIVERSITY

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1943

PRINTED IN INDIA

PRINTED AND PUBLISHED BY BHUPENDRALAL BANERJEE
AT THE CALCUTTA UNIVERSITY PRESS, 48, HAZRA ROAD, CALCUTTA

1454B—April, 1943—E

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PREFACE

The writer expresses his sense of deep gratitude to Dr. Syamaprasad Mookerjee, President, Council of Post-Graduate Teaching in Arts, Calcutta University, for his kind help and affectionate encouragement in the preparation of this hand-book. It was at the instance of Dr. Mookerjee that a laboratory was established in 1940, as a necessary adjunct to the Asutosh Museum of Indian Art. The Museum was founded in 1937 by Dr. Mookerjee, the then Vice-Chancellor of the University and through the energy and devotion of its Curator, Mr. D. P. Ghosh, it has now grown into a remarkable institution.

In 1940, the Curator felt the necessity of taking suitable measures for cleaning and preserving the valuable exhibits, numbering more than 7,000 pieces collected therein, and the services of the present writer were lent by the Department of Anthropology, Calcutta University, under the directions of Dr. Mookerjee. Later on, in 1941, a proposal was made to open museum-training classes and syllabuses were drawn up in accordance with the scheme in collaboration with the Archaeological Survey of India. But it is to be greatly regretted that due to the international situation it has not yet been possible to give effect to this important scheme.

The subject of Museum Method was introduced in the Calcutta University curriculum of the Post-Graduate classes in Anthropology as a special paper in 1936. Mr. T. C. Das drew up the syllabus and commenced work. Later on, when Prof. K. P. Chattopadhyay joined the University as the Head of the Department of Anthropology and began teaching the subject, the present writer was associated with him. The writer is at present in charge of the Museum Method Laboratory of the Department of Anthropology.

The Archaeological Survey of the Government of India has already opened sections for cleaning and preservation of museum exhibits. Dr. M. Sanaullah at Dehra-Dun and Dr. S. Paramasivam at Madras have taken up the subject in right earnest. But nothing practically has yet been done to find out a method of preserving articles under the peculiar influence of the moisture-laden, monsoon-ridden climate of Bengal, except a few scraps and short notes now and then published by the writer.

The writer is deeply conscious of the honour done to him by the Curator, in inviting him to write a hand-book on cleaning and preservation of museum exhibits in the moist and hot climate of Bengal. The writer has attempted to discuss the museum methods and has ventured to offer for the consideration of the

scientists some suggestions for the future development of this branch of Museology.

The writer acknowledges his indebtedness to Prof. K. P. Chattopadhyay, Dr. A. N. Chatterji and Mr. T. C. Das for valuable advice and suggestions and to Mr. N. K. Bose, Dr. M. L. Chakravorti and Mr. D. P. Ghosh for their help and friendly guidance.

CALCUTTA UNIVERSITY
The 10th December, 1942.

M. N. BASU

INTRODUCTION

Museum method is a subject of comparatively recent growth in India. It is practically in the embryonic stage. Its pressing demand has attracted the scientists in recent times. The object and scope of the subject are of utmost importance for the study human civilisation. The different phases of human civilisation have been recorded by their arts and crafts, etc., that can stand the inroads of nature for all times to come.

Museum method is principally divided into two groups :— (1) arrangement and (2) preservation of specimens.

Arrangement of the specimens for exhibition should be done properly. Exhibition is perhaps the most difficult aspect of the subject. Things may be arranged either in order of their distribution or evolution. A particular thing should be so placed that its actual importance might not be minimised by other things of the same nature. Arrangements of the specimens should be done in a way that would be interesting as well as educative to the lay people.

Museums are necessary for storing the results of field work. We are the outcome of the past ; unless we study our past, neither our present nor our future will be clearly understood. It is only clear when museums are set up and preservation and arrangement are done.

As there are different branches of study, different sections or departments should be set apart for the different sets of collections. Chronological aspect of arrangements may be regarded as one of the most important things to be borne in mind, specially in Historical and Archaeological sections. The arrangement should be such that even a general survey may be sufficient to give an idea of the gradual development of human activities and of the evolution in nature.

However, the writer's present subject does not require a detailed discussion about arrangement. He is here more concerned with the preservation of specimens leaving out the section on storing.

Preservation—Museum specimens are arranged and kept as far as possible in their original condition in which they have been found or collected. Unfortunately the climatic condition of Bengal is such that all the places of Bengal are infested with natural enemies. The enemies are not only trying to destroy the life-records of Bengal but also the past records of human achievement that may help in the march onward. It is an onerous task to preserve museum specimens. But at the same time modern scientific researches are finding out means of saving human records

from the attack of hostile forces. The destructive agencies of museum specimens are mainly of two kinds[1] (*i*) climate and (*ii*) insects. Climate, *i.e.*, variation in temperature and moisture, affects most articles and gradually deteriorates them. It is necessary to adopt means to keep the specimens in such a way that they may be in comparatively uniform temperature in dry places. Scientific preservatives should also be used to secure them against variations of temperature and moisture.

Insects of various kinds also eat into articles of wood, bamboo, leather, fabrics, etc. Careful treatment by chemicals is sometimes essential in preserving the life of the specimens.

Considering the importance of museum method the preservatives for different kinds of specimens are discussed here at length. The methods described in this treatise are used by the writer and on actual experiment he has found them very effective under the peculiar climatic conditions of Bengal, though some of them are in use in different museums of the world with slight modifications, and some are his own original works.

Preservatives may sometimes prove very costly. But the question of the importance of the specimens should be the criterion to decide whether such costly things should be used. Apart from the question of a museum the preservatives discussed here will be of great help in the preservation of household articles of everyday life. Here no doubt the economic question is vital. But some of the preservatives mentioned here, which are giving very good results, will be found to cost very little and not very difficult to handle.

[1] Details are discussed in the body of the treatise.

METHOD OF WORK

The work of restoration and preservation of old objects is divided into two categories :—

(1) *Method*—It is scientific and mainly chemical. The composition of the material of the object is to be ascertained.

(2) *Application*—Any change or deterioration of the object is to be determined, and suitable means should be adopted to remove the cause of the damage or to counteract the destructive elements.

Cleaning is the first step in restoration. First of all superficial dust and dirt are to be removed by means of a small soft camel hair brush or a small pair of bellows. After brushing or blowing off the over-hanging dust, if any dust be still sticking to the object, it should be removed by water or a mixture of benzene and petrol or alcohol, depending on the nature of the object. If water is to be used sparingly, it should be applied by means of a piece of cotton, sponge or soft brush. But when water is to be applied in quantity, the object should be immersed in it. In every case it is better to use warm water than cold. In some cases distilled water should be used.

Action of water on various objects :—

(1) Water should not be poured on wood unless it is hard and in good condition.

(2) Water can safely be used on metals but thorough drying is necessary before any treatment begins.

(3) Water should not be used on painted pottery or stone but may be safely used on varnished or waxed object.

(4) Glass, unpainted pottery or stone may safely be washed with water. Even soaking in repeated changes of water may be done.

(5) Water should never be used on plaster objects.

(6) Water should never be applied on ivory.

(7) Woven fabrics when in good condition may be wetted but when in bad condition water should not be used.

When water cannot be used, a mixture of benzene and petrol may be tried. But on oil painting it is not suitable. Potato or onion juice may be used with success on oil painting.

When water or benzene-petrol mixture fails to remove the dust and dirt deposits—

(1) Acids and alkalies should be used in a very dilute form.
(2) Acetone or pyridine may be used.

But two very important things should be borne in mind (1) patience and (2) necessary time to be observed.

After cleaning comes the next step—repairing, which means mending. Mending does not mean the addition of new materials but refixing of broken or loose parts. Lucas says that " success in repairing is a matter of manipulative skill, training, experience, patience and care."

An object should be cleaned before repairing. Old cementing should be completely removed from the object for adding the fresh and new one. Removing should be done by softening the accretion. Unknown cement preparations should not be used on the object.

The following adhesives are recommended for repairing :—

(1) Glue for wood.
(2) Celluloid cement for glass, porcelain, quartz, flint.
(3) Plaster of Paris for pottery, stone.
(4) Paste made of white portion of egg and flour [2] for porcelain.
(5) A solution of sodium silicate and fine stone dusts [3] for stone.
(6) A mixture of country-made cement and sand [4] for fire-baked clay or terracotta.
(7) Wax for ivory.[5]

Strengthening—Sometimes it so happens that an object is in such a fragile and delicate condition that proper handling is not possible without causing any damage. In such a case strengthening of the object must be done to secure its existence by impregnation with the following reagents in the liquid form :—

(1) Melted paraffin.
(2) Melted beeswax.
(3) Celluloid Solution.
(4) Linseed oil.
(5) Plaster of Paris.
(6) Green mangosteen extract (Diospyros Embryopteris).

[2] Mrs. R. K. Mondal suggested to the writer to do this as she herself was successful in mending a few tea-cups and saucers.
[3], [4] Solution used in the Asutosh Museum Laboratory for mending stone images and terracotta figures.
[5] Mixture of beeswax with carnauba wax or paraffin.

Renewing—Sometimes parts of the object may be missing. The addition of new material is then essential to replace the missing parts. This addition is known as renewing.

Care should be taken so that the addition of new material may be as much as possible like the original one. But not in all cases.

For the preservation of old objects cleaning, repairing, strengthening and renewing (if required) are essential.

The injurious conditions for the preservation are to be taken into full consideration. They are :—

(1) Light.
(2) Moisture.
(3) Atmospheric condition.
(4) Dirt and dust.
(5) Insects.
(6) Bacteria and fungi.

Light—Certain colours on cotton fabrics, paper, etc., fade and become soft and fragile under the action of direct sunlight. Similarly injury is caused by the diffused daylight but not so much as by direct sunlight. The complete protective measure is darkness. But in museums darkness has practical disadvantage as the specimens cannot be exhibited in darkness. So to compromise between the two, curtains to windows and covers to showcases may be taken into consideration. Lucas' viewpoint on light is given below :—

" The temperature effect of sunlight and different coloured materials vary considerably in their absorptive power for heat, black having the highest heat capacity and white the least. Hence since all colours exclude sunlight equally well, if the texture and thickness of the fabrics are alike, but since dark coloured fabrics absorb and transmit more heat than light coloured fabrics, the former are to be avoided and the latter chosen. But although white is the best of all colours from a temperature point of view, it may be objected to on aesthetic grounds or it may be desirable for economical reasons to have a colour that does not show the dirt so easily and in such cases yellowish tint should be chosen."

Coloured glass should be chosen in place of curtains or covers, but from economic point of view it is very expensive. From chemical point of view blue and violet coloured glass should be taken into consideration but in museums these two colours are not suitable. The satisfactory colour to be taken into consideration should be one near the middle of the spectrum—the yellow tint.

Moisture—It contains carbon-dioxide (CO_2) derived from the air and sulphur acids from the burning coal or coal gas. Moisture plays an important rôle in the following :—

(1) Life of bacteria and fungi.
(2) Action of Salt.
(3) Fading.

The moist air is therefore essentially required to be removed. This can be done by drying and proper ventilation. The use of calcium chloride ($CaCl_2$) inside the show-case has proved to be useful.

Atmospheric condition—If the temperature runs on a very great range the condition of the object becomes very bad. In high temperature the parts of the object sometimes crack and in low temperature squeezing is found, provided the two temperatures run in 24 hours. To avoid this condition as equable a temperature as possible should be maintained.

Dust and Dirt—These do not directly cause the damage of the object but they accelerate the cause. Occasional cleaning is required and the remedy suggested for this is to use dust and dirt proof show-cases.

Insects—Objects, specially of organic materials, are liable to be attacked and sometimes destroyed by insects. They are the larvae of beetles and moths, cockroaches, silver fish and white ants. These insects can be removed in two ways :—

(1) Preventing attack on the object.
(2) Killing the insects if attacked.

For the first item well-fitting show-cases, frequent inspection and cleaning and keeping crude naphthalene balls or camphor cakes or a powder [6] of orris root (*bach*), cloves (*labanga*), black-pepper (*golmarich*) and cinnamon (*daruchini*) in equal proportions, are the best preventive measures ; and for the second one fumigation should be done with the following chemicals :—

(1) Carbon dioxide
or
(2) 3 parts of ethylene dichloride and 1 part of carbon tetrachloride.

Bacteria and Fungi—Bacteria and certain vegetable growths such as lichens and fungi (moulds) are the main destructive agents to an old object. Moisture and warmth accelerate the growth of these bacteria and fungi. The object should be kept in dry condition.

[6] Specially prepared by the writer and is being used in some small libraries and museums for experiment.

Handling of Specimens

Human hands are always found to be greasy even when apparently clean. The grease of the hands is due to constant perspiration which contains acids and salt. In Bengal acid perspiration is noticeable in human hands. So to handle an antique object in museums one should be very careful. It is suggested that the hands should be covered with thin and fine rubber gloves.

Records of specimens are made on the basis of the study described in the treatise and all cases are included in this study. Records are kept in the following way :—

Museum Laboratory

Name of the specimen.....
Museum Number.....
Condition of the specimen.....

Date of Treatment	Reagent	Date of Inspection	Atmospheric Temperature	Barometric pressure	Humidity	Remarks

CLEANING AND PRESERVATION OF ORGANIC MATERIALS

Wood and Bamboo

For the preservation of wood and bamboo against insects hydrocyanic gas (HCN), carbon-disulphide (CS_2) vapour and kerosene and crude creosote solution may be used. But as hydrocyanic gas is too poisonous it is hardly used in museums. The other two are quite effective.

Fresh excavated wood is generally damp. It is to be dried otherwise shrinkage and warping may be so great as to cause irreparable damage. It is to be dried in a cool place for a few days (depending on the nature of dampness). After drying, the specimen is to be immersed in celluloid, vinyl-acetate or paraffin, otherwise the natural foodstuffs (starch, etc.) in the wood will attract insects.

The specimen (wood or bamboo) before laboratory treatment is washed with 5% carbolic soap and washing soda[7] and after drying it in the room carbon-disulphide vapour is applied.

A big ply-wood wooden box rendered air-tight by lining with black board cloth and thin brown paper is used for this experiment. The box is of $3' \times 2' \times 2'$ in size. At a height of 8" from the bottom four brackets are fitted inside the box at four corners. A movable perforated tray is placed on the brackets. Two cups containing 2 oz. of CS_2 each, are placed in the box. It is exposed to carbon-disulphide vapour for a week. To ensure further protection the specimen is re-exposed to the vapour for a week more in the carbon-disulphide chamber. If still the problem of having fungus or moth, etc., in the specimen arise, it should be subjected to creosote treatment.

As crude creosote is dense and very black and not suitable for application to any specimen directly, it is diluted in kerosene oil, so that the original colour of the specimen may not be lost. The proportion is as below :—

Kerosene	.. ..	2 vols.
Creosote	.. ..	1 vol.

The specimen is put in a trough (made of tin) and a solution of kerosene and creosote is sprayed with a syringe in and out or the specimen is given a thorough bath by dipping it into a bath trough containing the solution. After that the specimen is taken out and then exposed in an open place to dry up. Three days or 72 hours are required for complete drying. The next step is to paint shellac solution.

Shellac solution generally consists of the following ingredients :—

Shellac crystals
Methylated Spirit
Mercuric chloride

The strength of mercuric chloride ($HgCl_2$) in the solution varies from 1.5 to 2.0% according to necessity. Shellac solution may be prepared with the constituent chemicals, measured as follows :—

Shellac crystals	.. ..	20 gms.
Methylated spirit	.. ..	100 c.c.
Mercuric chloride	.. ..	2 gms.

The solution is now known as 20% shellac solution. Shellac crystals are broken into small pieces and mercuric chloride is finely powdered. The two are put in a bottle and methylated spirit is added. The bottle being corked very tightly the solution is shaken thoroughly and left for a week to be dissolved.

[7] In the Museum Method Laboratory of the Department of Anthropology, Calcutta University, the writer uses Fullers' earth (*Sajimati*).

The solution thus prepared is now brought out and it is applied with a brush very thinly.

Sometimes problems arise regarding the treatment of museum specimens, specially fish traps, etc., whose inner side cannot be painted with shellac solution by means of a brush. In those cases a flit gun is to be filled up with the solution (10% or less) and the contents sprayed inside the specimens.

Strengthening of wood is often attempted and also achieved by the application of glue or gelatine so as to fill up the channels and pores in the wood. In dry condition it adds much strength to the wood, but in damp atmosphere or where there is possibility of water vapour reaching the wood, the treatment is as follows :—

Hot paraffin wax or the solution is recommended for this ; but it does not add much in the way of strength. It however gives a good resistance against dampness. Any wood so treated is not likely to have any eggs, etc., of insects deposited on it. Sodium silicate (Na_2SiO_3) seems to promise well, the wood becomes hard and strong when dry.

Oil or grease spots may be removed from wood by soaking them in a mixture of benzene and petrol. Sometimes acetone is required. But to remove paint from the wooden objects (or even from the iron sticks or rods) [8] caustic soda and caustic potash in equal proportions should be applied and brushed. After brushing, washing should be done with water.

Wooden dishes, known as ' Barkosh ' in Bengali, are largely used for household purposes. A solution of green mangosteen (Diospyros Embryopteris) and *neem* fruit (Melia azardirachta) prepared and experimented by the writer may be safely used for the preservation of household wooden objects.

One thing is to be remembered that the numbering of the specimens in museum is very essential. The numbering is to be done immediately after collection and that should be done with enamel sapolin in the case of wooden or bamboo specimens and Reeves' water-proof ink for metallic and fabric specimens. After numbering with sapolin 2 days or complete 48 hours and with water-proof ink 3 days or complete 72 hours should elapse before any treatment begins.

Pigmented or Coloured Specimens

Thymol ($CH_3.OH.C_5H_7$) is a powerful fungicide and in museum it is used quite safely and harmlessly.

A big wooden box of ply-wood known as Thymol chamber, is rendered air-tight by lining with black board cloth. The box

[8] The writer was once asked to remove the paint from the door and window panels and iron rods of the windows in 1941. He was successful by using caustic soda and caustic potash.

is of 3′×2′×2′ in size. At a height of 8″ from the bottom four brackets are fitted inside the box at four corners. A movable trellis-work shelf is placed on the bracket. At the bottom inside below the shelf an electric point is fitted, on which a 50 c.p. bulb is placed. Immediately above the bulb a thin glass saucer (on a tripod stand) containing thymol crystals, is placed. The chamber is to be shut for two days, every 24 hours the bulb is to be switched on for 2 hours. Thymol crystals will begin to melt and the fumes will rise and envelope the specimen placed on the trellis-work shelf. After 48 hours the specimen is removed from the chamber.

Grass, Reed, Sledge and Cordage

Baskets, brushes (broom-sticks), matting, cordage, etc., are generally made of grass, reed, sledge, cane, etc. These objects when dry and also in course of time, become brittle. Superficial dirt and dust on them may be removed by brushing or blowing. But when in fragile condition, petroleum spirit with small brush or cotton is found to be very successful in cleaning. Water should be avoided. These objects may be strengthened by painting with wax. In the Museum Method Laboratory the writer uses a very dilute solution of creosote first (4 : 1) and then applies 2 to 5% shellac solution depending on the nature of the object.

Fabrics

Old woven fabrics disintegrate very much. Air, warmth and humidity are the main factors for the disintegration. The changes are :—

(1) Chemical—caused by oxidation.

(2) Biological—effects of bacteria and fungi.

Disintegration also takes place in sunlight.

Dirt deposited on fabrics that are in good state of preservation may be removed by soap and warm water. Rubbing is not necessary there.

Fabrics should be soaked in a solution of benzene and petrol for removing oil or grease stains. Sometimes it is seen that the stain is very persistent and removal may not be possible by treating with benzene and petrol. In that case acetone is a good reagent for the removal of the stain. The way of removing oil and tar from clothes [9] is to rub them in a solution of water, potash

[9] The procedure is adopted by the writer in the Museum Method Laboratory of the Department of Anthropology, Calcutta University. The process is as follows :— Half oz. lemon juice in 1 oz. potash & 2 lbs. of water should be thoroughly mixed and well filtered and the solution thus prepared should be kept in a bottle. The stain portion of the cloth should be rubbed with the solution and washed in ordinary water.

and lemon. The writer was also successful in removing in the same way stains on silken fabrics. He generally uses methylated spirit and spirit turpentine. These two chemicals should be poured on the stain and rubbed well. The stain is sure to leave the fabric.

Removing of ink stains depends on the nature of the ink. Warm water and gentle rubbing is necessary for carbon ink. Old iron ink without any blue colouring matter requires hydrogen peroxide. The second alternative is 10% oxalic acid. In that case oxalic acid should be allowed to remain on the stain from 3 to 5 minutes depending on the nature of the stain and washed with warm water. 10% oxalic acid or 10% tartaric acid alternated with dilute solution of bleaching powder and washed with warm water has made it possible to remove blue-black ink stain.

In daily life it is found that iron stains stick to the clothings. The stains can be removed by dabbing 10% oxalic acid solution and thorough wash with warm water. If washing be not a thorough one the fabric becomes tender.

When a fabric is found wet, it should be dried slowly in a warm room. Direct exposure to fire or some other source of heat should be avoided, as these will weaken the life of the clothes.

Sometimes it is noticed that old fabrics are in such a dry and tender condition that even folding is not possible without some damage. They are often so fragile that streaming or damping with water will cause them considerable damage. When such problems arise the fabrics should be damped with a solution of benzene and petrol or alcohol. This will enable the worker to handle the specimens safely.

Formaldehyde (HCHO) fume is very effective for the preservation of cotton and silk fabrics and paper goods. The specimen should be brushed very carefully. It is then subjected to the following treatment :—

20 oz. of water
&
2 oz. of formaldehyde solution (40%)

are put in a tin canister.[10] The canister is open at its top and is 18″ ×9″ ×9″ in size. At a height of 6″ from the bottom 4 brackets are welded at the corners. A movable ply-wood box with a hole (diameter 5″) at its bottom and with the opposite end completely open, is placed on the brackets. A fine sheet of wire-gauze is placed on this opening of the box so that no specimen may fall down. The specimen is kept on it and the canister is placed over a Bunsen burner on a stand. A wooden lid made

[10] It is known as Formaldehyde Chamber. It was specially prepared by Prof. K. P. Chattopadhyay for the Museum Method Laboratory of the Department of Anthropology, Calcutta University.

to fit the canister exactly is placed on the top. The fabric is fumigated for ten minutes, after which the burner is put out. The specimen is taken out after 24 hours and the treatment generally appears to be satisfactory. To dry up the little moisture it absorbs the fabric is kept in open air for several minutes (but not in the sun). Afterwards the fabric specimen is kept inside a Tarine Moth-proof bag.[11] A pound of naphthalene is also put into it. The mouth of the bag is closed and it is hung on its hooks from the wall.

Fabrics which cannot be removed from their positions for cleaning and preservation, are treated with a solution by means of tissue paper. The solution is prepared in the following way :—

10 gms. of glue and 500 c.c. of water are mixed and the solution remains for 24 hours. After 24 hours the solution is to be heated but boiling is to be avoided. The solution is always to be stirred till all solid particles are dissolved. The solution is then mixed with 2 c.c. of formalin and stirred. The final solution is to be applied immediately. Plenderleith names it Size Solution. The solution is to be applied on tissue paper, held firmly against the fabric.

Cotton thread is strengthened by rubbing it with the extract of green mangosteen (Diospyros Embryopteris). If a few drops of raw *neem* fruit juice (Melia azardirachta) be added to it no attack of moths or insects on it is possible.

Keating's insect powder is a good insecticide for clothes. Pieces of paper soaked in spirit turpentine should be kept in the folds of the garments to get rid of the insects.[12]

Books and Manuscripts.

The most dangerous enemies of books are white ants or termites, cockroaches and various types of book worms. According to Mr. W. Blades, Sir A. E. Shipley and Mr. T. M. Liams, the important book worms are—Silver fish, Lepismas, Anobium Pansicum and Book lice (corrodentia). Besides these wood boring beetles—Anobium Pertinax and Anobium Striatum attack books and bore through them. Almost all the book worms are nocturnal in their habit and they are fond of darkness. They do not like to come out in the daylight. They grow rapidly in the dark and when the rooms are closed for a long time. Moist climates and variation in temperature give them the opportunity to breed. Paper, wood, cloth, glue or any paste, etc., are their main objects of prey.

[11] The writer has prepared one sample moth-proof bag with all the country made materials. It is kept in the Department of Anthropology, Calcutta University.

[12] The writer is successful in using this process with a few garments, but one difficulty is that bad odour will have to be smelt during use.

The following preventive and curative measures should be taken into consideration for a library :—

(1) Dusting of books at regular intervals. (Dusts invite book worms.)

(2) Books should be exposed to sunlight for a short time. Long time will render paper brittle. Eggs and larvae of the insects cannot live under the direct ray of the sun.

(3) Phenyle should be sprinkled on the shelves and camphor tablets should be spread on the sides of the books.[13]

(4) Dry *neem* (Melia azardirachta) and tobacco leaves should be placed in the folds of the book pages.

(5) Books should be treated with some insecticides.

The chemicals used as insecticides in the Library of the Imperial Department of Agriculture and the Imperial College of Tropical Agriculture, are as follows :—

Corrosive Sublimate	.. ..	½ oz.
Carbolic Acid	.. ..	½ oz.
Methylated spirit	.. ..	1 pint.

This solution should be applied by means of a brush twice a year to the covers of the books both inside and outside.

Shell Tox is a product of Burma Oil Company and is very effective against the insects specially white ants. It can be used safely on paper, cloth, leather and photo-print without any injurious effect.

A solution of rectified spirit, mercuric chloride and phenyle is effectively used by the Keeper of the Punjab Government Records and the Punjab University Library. The proportion of the solution is :—

Rectified Spirit	.. ..	1 gallon
Mercuric Chloride	.. ..	1 oz.
Phenyle ..	.. ..	1 oz.

Another solution—

Corrosive sublimate	.. ..	50 drachms.
Creosote ..	.. ..	60 drops
Rectified spirit	.. ..	2 lbs.

should be applied with a brush in joints and between every ten or fifteen pages of the book. A little of this solution can safely be added to the paste used for binding books.

When books and the almirahs in which they are kept, are attacked with insects, benzene should be used as a curative. This chemical serves well when the rooms are closed.

[13] The writer uses a very dilute creosote solution. The proportion is 4 : 1. The dilution is made with kerosene oil.

Another suggestion is that equal parts of chopped tobacco and pepper be spread on the racks and shelves of the almirahs where books are generally kept. It is advisable to add Keating's insect powder to this. Pepper may be substituted by camphor. But whatever may be the ingredients, they should be changed every 2 or 3 months.

When books are terribly attacked with insects the remedial measure is fumigation by formaldehyde solution. (For full details see fabrics.)

Shipley justly remarked that "The real remedy to keep books fresh and free from damage is to have the Library in a building in which temperature and (relative) humidity can be regulated. Such a building exists in the Shell-filling factory at Dum-Dum, but its cost would probably be prohibitive in the rather starved libraries.....in the tropics."

Several books affected with insects were treated by the writer. They were fumigated by 40% formaldehyde solution [14] for five minutes [15] and were taken out of the chamber. A country made preservative powder—orris root (*bach*), cloves (*labanga*), black pepper (*golmarich*) and cinnamon (*daruchini*) in equal proportions—was prepared. After being powdered they were kept in small cloth bags and placed on the shelf where books were kept. Books have shown no signs of attack till the date of writing.[16]

Feathers and Hair

The most dangerous enemies of feathers and hair are various kinds of insects. These insects make their entrance into them and destroy them in course of time. To get rid of these insects it is advisable to keep the specimens of both feathers and hair in show-cases and naphthalene balls or thymol crystals should be kept there. If any specimen be attacked with insects it should be fumigated by formaldehyde or thymol in their respective chambers (described before).

In course of time specimens of feathers become very brittle and tender. So old specimens of feather cannot usually be cleaned. Their strength should be increased by spraying a very dilute solution of celluloid on them.[17] The writer suggests that any

[14] M. N. B.—Preservation of cotton fabrics, Science & Culture, No. 6, p. 188, 1940-41.

[15] Mr. Chakravarti of Research Laboratory, Imperial Record Department, New Delhi, has issued a note that the period should be at least 4 hours, but on experiment the writer finds longer time chars paper.

S. C. Chakravarti—Preservation of books affected with drugstore & beetle mildew, Science & Culture, Sept. No. 3, 1942, p. 141.

[16] M. N. B.—Preservation of books affected with insects, Science & Culture, No. 12, p. 617, 1942.

[17] Lucas has suggested dilute solution of celluloid but the writer has prepared the strength of the solution in 0.5% and used in many cases

oil absorbent chemical may do for cleaning when the specimens of feather are, of course, in good condition.

Hair sufficiently resists the ordinary influence of destruction. In the opinion of the writer it does not require any treatment excepting the removal of the oily substances from it. They can be done by ether, alcohol, etc. But alkali on no account should be used for the removal of the oily substances as this will spoil the specimen.

Leather

Leather is not a permanent material. In course of time its property changes—much change is generally noticed when it is not dressed.

The causes of decay of leather are various :—

(1) Atmospheric oxidation—influenced by light and heat.
(2) Action of acid, specially of sulphuric acid (H_2SO_4). This acid is sometimes absorbed as sulphur dioxide (SO_2) from the atmosphere or sometimes remain in leather from the time of tanning.
(3) Due to bad tanning.
(4) From dyes used.

The causes of decay may be prevented by regular application of suitable dressing to lubricate the tissues and to get it free from air and of sulphur gases. Castor oil, vaseline or lanoline are agents for dressing.

Raw hides and horse trappings should be painted with a mixture of 60 parts of castor oil and 40 parts of alcohol and then immersed for 24 hours in pure castor oil. Fine leather is sponged very carefully with a moist rag soaked in 5% carbolic soap water and is cleaned finally with a damp cloth soaked in water only. When cleaned ' British Museum Leather Dressing ' solution is used by means of cotton. The solution is made of the following chemicals :

Beeswax	7 gms.
Lanoline anhydrous	100 gms.
Cedar wood oil	14 c.c.
Hexane	170 c.c.

Beeswax and lanoline anhydrous being measured are put in a bottle and the required cedar wood oil and hexane are added. The solution is then stirred with a glass rod.

When leather is in a brittle condition and cannot be handled, the specimen should be treated with a mixture of 60 parts of alcohol and 40 parts of castor oil. The mixture should be applied with a soft brush.

It is advisable to be extra-cautious when using. Otherwise sticking of feathers with one another will destroy their appearance as a whole.

Sometimes leather is attacked with insects, *viz.*, cockroaches, silver fish, etc. The infected leather is then subjected to fumigation by carbon-disulphide (*vide* wood and bamboo).

For water-proof and dressing of leather, oil extracted by dry distillation from the seeds of *Sheal kanta* (Argemon Mexicana) gives satisfactory result. Oil extracted from *Mahua* (Bassia Latifolia Roxb) is a good reagent for softening of leather.

Ivory, Bone and Horn

Ivory is usually more permanent than bone and by nature denser than bone. So a small surface is exposed to decaying. The technique employed in the preservation of ivory can be applied very largely to bone.

Sometimes it is seen that ivory is coated with a hard incrustation of calcium carbonate ($CaCO_3$), and even sand and earth on calcium carbonate. Removal of these can be done by dilute acid. Generally hydrochloric acid (HCl) is used. The proportion of acid as recommended by Lucas is 5 parts of hydrochloric acid and 95 parts of water. According to him this should be applied by means of a brush over the incrustations. He further suggests that after treatment the specimen should be washed in repeated changes of water so that no trace of acid remains on it. Ivory can stand this treatment when in good condition. Old ivory should never be soaked in water as this may lead to unequal swelling and sometimes permanent warping. Brushing is necessary after excavation. Heat must never be applied for drying ivory. It will be completely destroyed if dried over a heater. It will also not be allowed to remain exposed to sunlight. The method of drying the specimen is to expose it to free circulation of air in a dry place. After drying sponge it with soft cotton soaked in equal parts of acetone ($CH_3.CO.CH_3$) and rectified spirit. After this it is to be protected by impregnation with wax or virtyl-acetate. But in the case of bone methylated spirit is used in place of rectified spirit and shellac solution (2% or 3%) with 0.5% mercuric chloride instead of wax or vinyl-acetate, depending on the nature of the bone, is to be applied twice, one coat should dry before the application of the next.

For the preservation of the inner side of a skull, be it human or of any other animal, cotton soaked with one or two drops of dilute creosote solution should be pushed into the inner part of the cranium through the foramen magnum.

Waxes are the best adhesives for museum ivory. A mixture of equal quantity of paraffin or carnauba wax and beeswax is generally used. The process is not a permanent one. For a more permanent process the cement required is very thin isinglass or white shellac solution.

Broken and fractured ivory should never be repaired with glue or ordinary shellac solution for these may stain the specimen. The cement mentioned should be avoided, as removal of the cement is very difficult and in future may require further repair.

Horn generally does not require any treatment except cleaning, and that should be done with warm water. Sometimes horn is found to be attacked with insects. The remedy is to keep it under fumigation in carbon-disulphide chamber. After taking out of the chamber 2% shellac solution may be painted on it.

Human Skeleton

The dead body is to be kept under the cover of a glass or porcelain vessel for a period of about 15 days; but 6 or 7 days are required for the head portion only. If it be placed under the earth colour generally changes to red. The period mentioned is required for the action of ostolysis. After this period the bones are to be cleaned by washing in water and scraping off the cartilages with a knife. Then the bones are to be boiled in water containing washing soda and lime for a short time (time varying with the nature of the bone). The bones of the skull require shorter time than those of the other parts. The proportions of washing soda and lime are 50 and 70 gms. respectively. The bones are then again to be washed in water and dried in the sun for 3 or 4 days. After drying, if there is any spot anywhere, it may be touched with very dilute hydrochloric acid and are to be washed again in water. When the bones are thus cleaned they should be painted with 2% shellac solution (white shellac is preferred).

PICTURES AND PAINTINGS

There are various classes of pictures. They are as follows :—

1. Mural paintings.
   (*a*) Tempera.
   (*b*) Fresco.
2. Paintings on plaster.
3. Paintings on wax.
4. Oil paintings.
5. Prints and drawings.

Tempera—Adhesive medium is required for the pigment. Glue, gum or white of egg serve the purpose of the medium. Dilute solution of ammonia may remove lichens from the tempera paintings. A gentle brushing, washing with water and alcohol are necessary for final cleaning. Sometimes smoke, dirt, dust, mud, spider webs, certain birds' excreta and even white wash deface the painting. To bring the painting to its original

condition brushing should be done with a soft brush. After that a mixture of benzene and petrol should be applied with a soft brush.

The chief enemy of the painting is salt. This salt may be removed by giving few coats mildly (with a soft brush) with 1% celluloid solution dissolved in equal parts of acetone and amyl-acetate.

Fresco—For the cleaning and restoration of frescoes Church [18] suggests the following :—

(1) Careful brushing.
(2) Application of alcohol with cotton.
(3) Coating the surface with a paraffin wax mixture.[19]

Paintings on plaster—Dust and dirt can be removed from the varnished surface by means of damp sponge or cotton soaked in a mixture of benzene and petrol. One should be careful when excess water is to be used, as there is every possibility of water penetrating through the cracks of the plaster. If water enters through the cracks it will disintegrate the specimen rapidly. Alcohol should be avoided as this will remove the varnish.

A mixture of benzene and petrol can be safely used for removing dust and dirt from the unvarnished surface of the paintings. Alcohol and water should be avoided as the paint will be removed by the former and the plaster will be destroyed by the latter.

Unvarnished plaster objects (paintings) may be strengthened by 2 or 3 coats of 1% celluloid solution. Repair works should be done with celluloid cement. Paraffin wax should be avoided as this will darken the plaster and paintings, but on varnished object paraffin wax may be safely used.

Paintings on wax—Pliny [20] has termed it *encaustic painting*. Dirt and dust can be removed by rubbing both water and methylated spirit on wax surface.

Oil paintings—Cleaning of oil paintings is not only a fine manual work but also requires a clear cut knowledge about the constituents of the pigments, mediums, varnishes and chemicals used in them.

No picture should be cleaned or restored without a full preliminary examination by scientific methods. Moreover a full record of all the operations should be kept, both by means of photography and writing.[21]

[18] A. H. Church—The Chemistry of Paints & Paintings, 1915, pp. 356-57.
[19] Melting 4 parts of paraffin wax, 1 part of turpentine and 15 parts of toluol.
[20] Natural History, XXXV, 31, 39, 41.
[21] Mouseion, Vol. XIII & XIV, 1931, p. 165.

One per cent saponin [22] solution is a good reagent for cleaning dirt and smoke deposited on an oil painting. Saponin solution should be applied with a pad of cotton wool which should be damped, and not soaked in the solution. This process was first brought to the notice of Mr. L. Lucas by Sir Robertson and it was also recommended by Professor Laurie.[23] In February, 1941, the Curator, Asutosh Museum of Indian Art, Calcutta University, gave the writer two wooden manuscript-covers for cleaning. Both sides of each manuscript-cover were as black as ink. The wood, on enquiry, was found to be *Sal* (Sorea robusta). It was collected from the district of Chittagong.

The specimens were treated with potatoes, onions, methylated spirit and spirit turpentine in a particular order. On the first day a big potato was cut with a knife and the cut surface was rubbed in a circular motion against the outer side of both the specimens. On the second day the same process was repeated but the reagent was only onion which was also cut into two pieces and after the application of both potato and onion black dusts were removed with dry cotton. On the third day after repetition of the second day's process writing appeared on certain portions and gradually colours were seen. On the fourth day the same process was repeated and on the outer side of one of the corners "Dasavatar" scenes became clearly visible while on the outer side of the other plank portraits of Jagannatha, Balarama, Subhadra and of others were visible. Then on the fifth day a cotton swab damped in methylated spirit was applied on a part of the outer cover immediately followed by another cotton swab damped in spirit turpentine. Care was taken so that the time between these two applications did not go beyond one second. The process was continued for ten minutes daily and repeated sucessively for seven days. After that a good result was obtained.

On the inner side of both the specimens the colour that was observed was also black, but on rubbing potato and onion with a circular motion one after another on the same day and on applying methylated spirit later on, yellow colour appeared. There was no painting on this side but on each specimen three lotuses were found engraved in a line.

After cleaning, a very thin coat of liquid paraffin was applied on each side of the specimens and they have been kept under observation.[24]

According to Church the application of bread crumb on oil-painting in the way of an India rubber is a good method for cleaning.

[22] Saponin is a white powder obtained from the common soapwort (Saponaria officinalis).

[23] A. P. Laurie—The painters' method & materials, 1926, p. 231.

[24] M. N. B.—Cleaning of oil painting on wood, Science & Culture, Vol. VII, p. 570, 1942.

The crumbs of a loaf one day old is to be taken out and rolled gently on the painting by fingers. This process is to be repeated with new pieces of crumbs until the colour comes to its original condition.

The Curator, Asutosh Museum, handed over to the writer seven Orissa paintings for cleaning. The paintings were very old and worn out. The writer cleaned them with crumbs of one day old Firpo bread. For each painting the writer had to devote 3 days, each day working 2½ hours. All the paintings were in multi-colour. The paintings are now clearly visible.

Picture varnishes fall into two categories :—

(1) Resin—Soluble in alcohol, so it should be used to remove resin.

(2) Resin dissolved in drying oil—cleaned by canada-balsam and a few drops of ammonia. After this treatment the picture should be carefully washed with turpentine.

While working in the laboratory, if it is found that the solvent acts very quickly, the action may be restrained by some restrainer.[25] The restrainers used in the labortaory are—spirit turpentine, linseed oil and castor oil. The first two are quite effective while the third one is not a drying oil, so it should be removed when its work is finished, which should be done with turpentine.

Oil paintings on canvas or wood require constant attention. The paintings should be kept in a room where the atmospheric temperature and humidity should be equable. Direct or reflected sunlight should be avoided.

Prints and Drawings

Prints suffer very much due to discolourisation. This may be removed by the following treatment. First of all over-hanging dust on the prints should be removed by means of a soft brush. After this the prints should be placed in a shallow steel dish containing ordinary water and subjected to sunlight exposure for 2 or 3 hours. After this the prints will be free from discolourisation and cleaned and dried by white blotting paper and then placed in-between two fresh blotting papers with a uniform pressure for 8 hours.

If the discolourisation caused by mildew is a considerable one a bleaching agent should be used. According to Lucas they are as follows :—

(1) Hydrogen peroxide.
(2) Bleaching Powder with hydrochloric acid.
(3) Sodium hypochlorite with hydrochloric acid.

[25] Suggestions given by Mr. Atul Bose, the artist.

Oil or grease spots on the prints can be removed by applying cotton soaked in a mixture of benzene and petrol. If it fails, acetone should be used.

Removing of ink stains has already been discussed in connection with fabrics. When the print is attacked with fungus, fumigation with thymol is a good method as advised by Scott. But the writer is in favour of using formaldehyde vapour.

A photo-print is to be retouched with water-proof ink. After drying completely it should be immersed in a solution.[26]—

Iodine	..	.. 15 gms.
Potash Iodide	..	.. 46 gms.
Aqua dist.	..	.. 3.5 oz.

After the immersion the photo should be dipped in hypo-solution, the photo colour will be bleached, and the line drawings will be prominent ; and finally the print should be washed under ordinary tap water.

In course of time drawings and water colour paintings become discoloured. This is due to the action of sulphur acids in the atmosphere on white lead pigment. The use of hydrogen peroxide will change dark coloured sulphide into white sulphate. "As the usual water solution of this reagent would be unsuitable in the case of water-colour paintings, patels, charcoals and pencil drawings, which would be ruined by water, Church recommends ethereal solution. This, too, has been used by Scott, who also employs the same alcoholic solution he uses for mildew. The solution is applied with a small brush."

FOODSTUFFS AND LEAVES

Leaves

A solution with 4 gms. of mercuric chloride and 200 c.c. of 75% rectified spirit is prepared. The leaves to be preserved are dipped in it and dried on a blotting paper. Finally they are fixed on a cartridge paper by means of a silk thread. Before sewing the leaves the thread is also dipped in the above solution.

For the cleaning of dry painted leaves, specially palm, juice of country beans is recommended by the writer. The method of use should be like that of an India rubber fashion.[27]

Mr. D. P. Ghosh, Curator, Asutosh Museum of Indian Art, found on enquiry from local Oriya artists in Puri district that palm-leaf manuscripts with incised drawings are best cleaned by the application of the juice of green *Pui* (Basella rubra b) leaves.

[26] Mr. N. K. Bose of the Department of Anthropology, Calcutta University, has given the writer the formula.

[27] Suggestion of Mr. N. K. Bose.

Cereals

A solution of 5 gms. of mercuric chloride and 200 c.c. of 75% rectified spirit is prepared. Cereals, such as pulse, rice, wheat, etc., are to be dipped in it, then brought out and dried in a shady place. They are then to be kept in a glass corked small jar with one or two balls of naphthalene.

For household purpose rice is to be mixed thoroughly with common soda and kept in a big basket. The proportion of soda should be one sixteenth to one twentieth part of the rice contents. Ordinary lime powder may be used instead of soda. The proportion should be less than that of soda. But one difficulty is that the vitamin B contents of the rice is lost in case of lime. The writer is now engaged in carrying out investigations with turmeric powder. Turmeric powder is to be mixed with rice in the proportion of 15 : 1. But from commercial point of view it does not satisfy the condition fully. First point is taste and the second one is that a Bengali Hindu widow will not take the rice mixed with turmeric powder. But whatever it may be the writer is now in a position to say emphatically that the turmeric powder is a good insecticide specially for the cereals.

Eggs

Fresh or one day old egg is to be dipped in lime water for a period of seven days. After that the egg is to be taken out of it. By this treatment the egg keeps good for an average period of two and a half months. In winter, from mid-November to mid-March, preservation of egg is possible for 3 months or more, if subjected to above treatment. The atmospheric temperature and relative humidity are favourable for preservation. But during the rest of the year it is good for about 2 months. Detailed study is always welcome, as from commercial point of view it is of much importance to the people.

Potato

Potato does not grow widely in Bengal. But it forms an important dish with the Bengali diet. Bengal soil is washed by the rains during the rainy season. Potato does not grow in low lands or lands where water can make its free access. So specially during the rainy season potato preservation is very necessary.

Potato is to be dipped in a very dilute solution of sulphuric acid. The strength of the solution should be 98 parts of water and 2 parts of sulphuric acid. This strength should be maintained during the winter months specially from the middle of November to the middle of March. But during the hot and the rainy seasons the parts should be 96 and 4 respectively.

Old potato should not be treated in the above way. Potato of not more than a fortnight old should be treated.

Treated potato will serve the purpose of food when cooked. But this potato will not germinate.

SILICEOUS MATERIALS

Clay

Common clay is principally aluminium silicate (Al_2SiO_3) mixed up with a large number of substances like compounds of iron, calcium, magnesium, manganese and other vegetable matters.

Clay specimens are divided into three groups :—

(1) Fire-baked
(2) Sun-baked
(3) Unbaked.

Fire-baked or Terracotta—For strengthening friable specimens celluloid solution is to be impregnated. A mixture containing beeswax, resin and carnauba wax hardens such specimens with slight change of colour. The proportions of the mixture[28] are as follows :—

Beeswax	..	..	75 parts by weight
Resin	..	..	15 „ „ „
Carnauba wax	..	..	5 „ „ „

In the Asutosh Museum Laboratory the writer has treated more than a dozen sealed bricks of various size (fire-baked) by dipping them in distilled water. Distilled water was changed once every 24 hours and the process continued for a period of one week.

The writer was also successful in using old household bricks in ordinary water and tamarind juice a few years ago. No salt is yet found to be present on those bricks. Another suggestion was given by the writer to paste cowdung cakes on the brick walls which are already affected with salts. This also has given a good result. In Bengal houses are constructed with faces east or south. The wind comes from the south as the Bay of Bengal is on the south. Naturally the wind contains salt substances which are readily attracted by the fire-baked clay or bricks. It is found that the southern walls of the houses are affected with salts. To get rid of the salt the bricks before being placed on the wall should be completely washed by water and tamarind juice.

Sun-baked—The specimen is sometimes very frail and even liable to be damaged when much salt is present. The specimen

[28] This formula has been suggested by F. O. Barlow of British Museum as a suitable reagent for hardening plaster casts.

may be wrapped completely with a pulpy blotting paper soaked in distilled water [29] for a few days (*i.e.*, so long the salts are dissolved).

If the inscribed surface is much cracked, it is to be impregnated with celluloid in acetone ($CH_3.CO.CH_3$) 2% and when the solvent evaporates soaking in changes of distilled water is to be done till the specimen is free from soluble salts.

When the specimen is in good condition it may be soaked in distilled water to get rid of the soluble salts.

When the specimen is not treated with celluloid the following baths recommended by Plenderleith may be given :—

(*a*) Dilute hydrochloric acid (HCl)—to remove lime incrustations.

(*b*) Dilute ammonia (NH_4)—to neutralise hydrochloric acid.

(*c*) Ammonium carbonate ($(NH_4)_2CO_3$)—to remove residual calcium sulphate ($CaSO_4$).

(*d*) Repeated changes of distilled water—to remove ammonium and other soluble salts.

After this the specimen is dried, the process of restoration will be completed by impregnation with celluloid.

Latest researches on sun-baked clay show that the problem of removing the salt contents was solved by giving the specimen 2 coats of very thin celluloid varnish (2%), each coat to dry before applying the next and then immersing completely the specimen in distilled water and continuing washing for a few days. After washing free from salts the specimen is dried and given a final coating of celluloid varnish (2%). The skin of celluloid over the surface of the specimen diffuses to crystallise readily through it. Immediately within an hour a strong white precipitate of silver chloride (AgCl) is usually seen.

Unbaked—This specimen is very frail and preliminary cleaning cannot be done by water as the specimen falls to pieces when wetted. It can be done by bellows and warmed near a furnace. After it is hardened or baked, blotting paper soaked in distilled water should be wrapped to remove salt. The specimen is then slowly allowed to dry and when dried two thin coats of celluloid in acetone ($CH_3.CO.CH_3$) 2% are given.

Glass

Glass is an amorphous, transparent or translucent mixture of a number of metallic silicates, one of which is usually that of an alkali metal—according to Thorpe's definition.

[29] In the Asutosh Museum Laboratory the Excavation Officer, Bangarh Excavations, handed over to the writer one round sun-baked clay seal for treatment. The writer wrapped the specimen with ordinary blotting paper soaked in distilled water for 5 minutes on the first day and 2 minutes next day. The interval between the 1st and 2nd day is more than 72 hours. The inscribed portion is now clearly visible.

The chemical formula of glass stands thus :—

$$XR_2O, YMO, 6SiO_2$$

R=atom of an alkali (K, Na, etc.)
M=atom of a bivalent metal (Ca, Pb, etc.)
X and Y are numbers of molecules.

Glass is made by melting sand and some basic substances together, such as soda (Na_2CO_3), potash (K_2CO_3), lime ($CaCO_3$) and oxide of lead (PbO). This gives rise to formation of mixed silicates which in composition vary largely. In museum specimens of soda lime glass (Na_2O, CaO, $6SiO_2$) and lead glass (K_2O, PbO, $6SiO_2$) are generally found.

Glass does not generally require any treatment when in good condition except washing with warm water and soap and drying with a clean warm cloth.

Sometimes moisture is attracted by an object of glass and is observed in the form of little globules and these globules flow over its surface in streams. This condition does not usually occur, but certain types of glass and special atmospheric conditions may lead to this. After a few days it is seen that the glass has lost its original brilliance. On examination with a powerful lens it is seen that the loss of brilliance is due to a multitude of small pits on the glass. The causes of this phenomenon is a mixture of excess alkali (potash) in the glass. The excess of alkali required to combine with silica (SiO_2), remains in a very loose state of combination and attracts moisture and carbonic acid (H_2CO_3) from the atmosphere and forms a strong alkali. This attacks transparent silicate of the glass leaving calcium and other silicates in an opaque form. This glass is then said to be 'diseased.'

1% dilute sulphuric acid (H_2SO_4) diluted with distilled water cures the 'diseased' condition of the glass. The glass is to be dried and given a coat of very thin dammar varnish which restores the original brilliance and forms an additional protection against further change.

When glass is found to be sweating and is in the early stage of decay, it is to be soaked in changes of very dilute sulphuric acid (H_2SO_4) for a period of ten days. After ten days it is to be washed under running tap water for an hour only and then dried in alcohol. After drying two very thin coats of canada-balsam in toluene ($C_6H_5CH_3$) is to be given.

The second report (1923) of the department of scientific and industrial research of the British Museum has stated that in case of advanced decay of glass acid should not be given. The procedure is simply to wash such glass under tap water at intervals (say for a week) and then the glass specimen is to be exhibited in an air-tight case containing calcium chloride ($CaCl_2$).

Putty powder has given good results when glass is attacked with fungus. Scratches and other defects on the glass can be

removed by xylol and methylated spirit and finally cleaned by chamois leather.[30] Xylol treatment and putty powder can safely be used for cleaning the lenses of microscopes, photographic cameras and spectacles.

Ordinary glass can be cleaned by chalk dusts and methylated spirit solution. The solution prepared is to be painted on the glass and dried. After drying the glass should be cleaned by dusters.

It is very difficult to repair transparent glass satisfactorily. The cement, *viz.*, celluloid, vinyl-acetate and canada-balsam, is to be applied very thinly and the fractured surface is to be slightly warmed before cementing. Isinglass is sometimes used.

For broken glass and porcelain (specially tea cups and plates) coaguline, an adhesive agent prepared by Kay Brothers, Ltd., Stockport, has given very good results. The writer is now engaged in using 'Duco' a patent cement for household articles. His experience for the last one year has produced a successful result.[31] In the Asutosh Museum Laboratory the writer is successful in using sodium silicate and fine stone dusts in solution. He made experiment on stone images first and then on porcelain articles.

Plenderleith has said "As in the case of pottery-mending the glue type of adhesive is preferable to celluloid and resin in cases where joints may have to be softened later for moulding."

Enamel

Enamel is merely a form of glass, varying in translucency and colour.

The method of cleaning enamel is ordinarily warm water. Warm water should be applied by means of cotton. But in cases when warm water is not sufficient, soap and water should be used. When both water, and soap and water are without any effect, petroleum spirit (a mixture of petrol and benzene) should be used. Lucas has suggested to use alcohol but the writer was successful in using methylated spirit for cleaning enamel in January, 1941.

Fossil

Just after an excavation, a specimen cannot be studied minutely, as it is generally covered with matrix and other particles. It should be dressed and cleaned to bring out the structural details for specific identification.

[30] The writer's personal experience on his own spectacles has proved very successful.

[31] In the Museum Method Laboratory he first of all tried to mend a broken Mishmi wood spear with 'Duco.' His result came out successful. Then he made experiments on terracotta figures, metals, leathers and fabrics with successful results.

Proper care should be taken in holding and handling a specimen which is to be cleaned. In the case of a delicate and fragile specimen, which is liable to crumble we should be extra-cautious. It should be held deep inside the palm of the hand or on a sand bag or gunny cloth. It is advantageous in case of certain specimens to put them under water for cleaning.

A specimen should at first be cleaned superficially by means of a brush. It is better to apply some hardening fluid before removing the matrix from the fossil. The best is 2.5% white shellac solution. An ordinary shellac solution of the same strength will also serve the purpose. For hardening, a little of this solution should be applied by means of a brush. The joints and cracks should be specially brushed. This process should be repeated until the specimen hardens.

After hardening a specimen by means of shellac solution and when it is completely dried, the matrix which is left on it, may be safely scraped by means of an ordinary pen knife, a needle or a chisel. When the matrix is very soft a steel pin should be used. During the process of dressing the specimen should be brushed with shellac solution from time to time, to fill in any new cracks and this would prevent the specimen from fracture or breaking. Sometimes it so happens that the matrix is very hard and cannot be removed by any mechanical process. Dilute hydrochloric acid (HCl) serves as an effective agent for removing the matrix. The specimen should be dipped in the acid for 5 minutes. After that it will be found that matrix is dissolved.

In dealing with fossil, jaws with teeth, special care should be taken of the base, which is often very fragile and liable to crumble. To prevent this, thin or thick coat of plaster (plaster of Paris), depending on the nature of the specimen, should be applied at the base. The dry powder is carefully mixed with water, as it dries up very soon. The worker should be very quick in its application. When the plaster dries up, the unwanted part of the specimen can be scraped by a pen knife and the base can be smoothed.

Delicate specimen which cannot stand handling, can be very easily fixed in a wooden box by means of a cement. Sometimes while cleaning and dressing fossils do crack inspite of great care. These cracks should be filled up by plasticine. In dealing with fossil jaws sometimes teeth come out; they should be fixed in their original place by means of cement.

Thus after cleaning and dressing a final coat of 5% shellac solution should be applied, care being taken that the sutures and the structural details are not covered up.

After cleaning and dressing the fossil should be treated with some preservatives. The question of preservatives used must necessarily depend on the nature of the specimen. When the specimen is a big one shellac solution seems well but the specimen

should be completely dried before the application of shellac solution.

Browning's preservative solution is an effective agent for this. The chemical ingredients of this solution are purified copal (Mexican gum), paraffin and petrol or spirit. The strength depends on the nature of the specimen (as in the case with shellac solution). The solution prevents dampness and it has a penetrating power which hardens the fossil. But the disadvantage of this is that it is highly inflammable and it has a very bad odour. It completely protects the specimen from outside atmospheric conditions.

Carbon tetrachloride (CCl_4) can be used as a preservative. It is not inflammable and is free from bad odour.

Potash silicate (K_2SiO_3) thinned by water can be used as a preservative. It acts as a hardening as well as a preservative agent. Perpetuin is fixative which has advantage of greater penetrating power than potash silicate and it is more durable.

Zapon (cellulose and amyl-acetate) is also another effective preservative agent. This is applicable to very delicate fossils. It serves well in the case of shells and plant fossils. It forms an imperceptible coating and it has the advantage of intensifying the structural details and the colour of the fossil.

Common washing soda should be placed inside a show-case. Raw naphthalene can also be kept which absorbs moisture. Sometimes a specimen is better preserved in a box. Powdered chalk is kept inside the box and over it a thin layer of cotton is placed and finally the fossil stands on the layer of the cotton. This prevents oxygenation.

METALS

Copper and Bronze

In ancient times the most important metal used was copper. Cleaning and preservation of copper objects and their alloys in museum present a complicated and vast field of study. Copper is invariably found to be mixed up with lead, arsenic, etc. Objects of copper and its alloys usually withstand corrosion. But burial in soils containing salts and limestones helps corrosion of such objects. Action of moisture and that of air and carbonic acid gas (H_2CO_3) also play an active part in corroding the metal and its alloys.

When copper or bronze specimens are corroded beyond recognition washing under hot running water is necessary. Last bath should be given in distilled water. When it is dried a coat of 2% celluloid is to be applied.

When the specimen is heavily incrusted but retain the metallic core, treatment can be satisfactorily carried out in many cases by the following method.

The specimen is to be treated by applying citric acid ($CH_2.CO.OH$) solution. The solution to be used should be 2%. If any part of the bronze specimen is cleaned before other parts, the cleaned area is to be painted with very light molten beeswax, even when washing of the other parts of the specimen is going on. When cleaning is completed the wax is to be removed with hot turpentine before final cleaning.

For cleaning copper, bronze and brass and removing the incrustations deposited on the metals, a solution of ammonium chloride (NH_4Cl), stannous chloride ($SnCl_2$) and dilute hydrochloric acid (HCl), prepared by the writer in the Asuotsh Museum Laboratory, Calcutta University,[32] has been used with much success. The proportion of the solution is :—

10 gms. of NH_4Cl
10 gms. of $SnCl_2$
30 c.c. of dilute HCl.

After washing the specimen with the solution stanolax oil is to be painted to get the specimen free from moisture and air.

Sometimes in the laboratory 2% caustic soda (NaOH) solution is used for cleaning the incrusted parts of bronze or copper metal.

The method of employing granulated zinc and dilute caustic soda solution gives a very good result on copper and bronze. The specimen to be treated, covered with granulated zinc and 5% caustic soda solution, is placed in a porcelain pot. The whole thing is gently boiled. The specimen is kept in it until it is cleaned. The specimen is to be taken out of the pot every 15 minutes for examination [33] till it is found to be cleaned ; everytime it should be cleaned under clear running water. Finally when the specimen is cleaned it should be washed and dried well. This treatment is known as Electro-Chemical Method. After this treatment if any spot of corrosion be found to remain on the specimen it should be cleaned with Rochelle Salt according to the suggestions of Lucas.

In cities and large towns it is seen that copper specimens sometimes become covered with a kind green patina. This patina is due to copper carbonate, basic chloride and sulphide. Even near the sea the patina contains a large proportion of basic-chloride.[34]

Dr. Sanaullah [35] has prepared a mixture of 1 part tartaric acid, 1 part caustic soda and 10 parts water for cleaning copper

[32] M. N. B.—Cleaning of copper, bronze & brass specimens in mureum, Science & Culture, April, 1941.

[33] W. H. J. Vernon & L. Whitby—Open air corrosion of copper, Journal of the Institute of Metals, XLII, 1929, pp. 181-202 ; XLIV, 1930, pp. 389-96.

[34] *Ibid.*

[35] Annual Report of the Arch. Survey of India, 1924-25, published in 1927, p. 141.

specimens. He has also stated that the action of the mixture is quick and effective and from an economic point of view it is cheap. He says "After the object is cleaned it should be well washed by first soaking it in repeated changes of water for several hours and finally leaving it in water over night as thorough washing is essential."

Sometimes a specimen shows spots of green corrosion though in a good condition. This is known as 'Bronze disease.' This disease is mainly due to the presence of copper oxychloride. The remedy is to soak the specimen in sodium sesquicarbonate solution. The strength of the solution should be 20 parts sesquicarbonate and 100 parts water. Sesquicarbonate parts may be increased depending on the nature of the disease. However the strength should not be above 35%. After treating in sesquicarbonate solution the specimen should be washed and dried.

When a specimen is considerably corroded the whole of the corrosion can be removed by means of cold dilute solution of sulphuric acid (H_2SO_4). The strength of the solution would be 5 to 10 per cent.

For cleaning of copper specimens rubbing with the leaves of oxalis corniculata [36] has proved very successful. These leaves are now being used by the writer in the Asutosh Museum Laboratory for further experiments.

Lead

Lead was known to the ancient Egyptians. It oxidises quickly in moist air, so a superficial tarnish is noticed.

For cleaning and preservation of leaden specimens the method is careful application of dilute acids by means of a brush. The acids generally used in the laboratory are acetic acid ($CH_3.COOH$), nitric acid (HNO_3), and sulphuric acid (H_2SO_4). The acids dissolve or decompose the lead carbonate ($PbCO_3$) and form an incrustation. If acetic acid is used the subsequent washing must be very thorough, and in every case it is well to begin the washing with an alkali (dilute caustic soda, NaOH) either with or without lead oxide (litharge, PbO) dissolved in it. After this a quantity of distilled water should be boiled vigorously for 10 minutes in order to remove carbon dioxide (CO_2) and the leaden specimen then rinsed in hot water. Enough of this is then poured over the specimen to cover it and the water brought to boil and kept there for five minutes before decanting it away and replacing it by a fresh lot. These operations are done twice and the washing is then tested for neutrality by litmus paper.

[36] A kind of acid plant known in Bengali as *Amrul* (David Prain—Bengal Plants, Vol. I, p. 294).

There are two kinds of corrosion noticed on leaden specimens :—

(1) Slight—Remedy 10 parts of acetic acid and 90 parts of water by a brush, repeating till the corrosion is removed.

(2) Considerable—Soaking the specimen in the acid of the same strength but brushing at intervals is required. After this treatment the specimen should be washed well in dilute ammonia solution for a short time. The strength should be 5 parts of ammonia and 90 parts of water.

Jenkinson [37] has cleaned leaden seals with 8% hydrochloric acid (HCl). These seals have been treated with dilute ammonia (NH_3) to neutralise the acid. These have again been washed with soda and dried by alcohol. Coating on them was done with methyl cellulose in place of celluloid.

The department of scientific and industrial research of the British Museum has published in its second Report (1923) that a coating of celluloid varnish dissolved in equal parts of acetone and amyl-acetate has retained the appearance of many leaden specimens perfectly and has been successfully used during the past year.

Tin

Tin is not an old metal, so specimens of ancient times made of tin are also very rare. Cleaning should be done with soap and water aided by a brush. But tin corrodes very much. Soaking in dilute sulphuric acid (H_2SO_4) gives satisfactory result. The specimen should be taken out of the acid and brushed well and repeated changes of water should be resorted to.

Linseed oil also acts as a good preservative on tin.

Silver

Silver is known from the very earliest times. The Alchemists gave it the name of Luna or Diana from the moon.

Silver is a very soft metal and for this it is not well adapted to the wear and tear of daily use. This softness is overcome to a large extent for coinage and other purposes by alloying it with other metals, of which copper is the most important. The amount added varies enormously, *e.g.*, the British Standard Silver contains 7.5% of copper, while some silver coins of Emperor Probus were found to contain only 4.5% of that metal.

[37] H. Jerkinson—Some notes on the preservation, moulding & casting of seals. The Antiquaries Journal, Vol. IV, 1924, p. 396.

When alloys of silver and copper are in contact of influences promoting corrosion, the copper decays quickly and the silver is protected so long as any free copper remains. In many cases green coating has led objects composed of alloys with a high silver content to being actually catalogued as bronze.

Sometimes articles of silver are converted entirely to silver chloride (AgCl) and in consequence become very brittle. By treatment with caustic soda (NaOH) and zinc these are slowly reduced once more to the metal, naturally in a spongy condition. After thoroughly washing out all soda (NaOH) these are dried and then raised to a low red heat. The heated silver has a soft grey colour and it is then varnished and rendered brilliant.

The use of formic acid (H.COOH) in various strengths both hot and cold for cleaning all kinds of silver alloys, specially those with copper, has given excellent result. As formerly pointed out, the case with which incrustations are attacked, varies very much and this is due to the remaining metals and the proportions in which they occur in silver alloy. When the formic acid fails to act readily, the applictaion of zinc dust and very dilute sulphuric acid should be resorted to.

The dark brown or black discolourisation is usually due to the formation of silver chloride (AgCl) or of silver subchloride, the latter being formed by the decomposition of normal chloride of silver by the action of light and organic matter and these two silver compounds are the insoluble substances which are loosened and then removed by gentle friction. This is done by soft pad of cotton-wool or fingers but brush is necessary when there is embossed or engraved work.

According to Lucas the degree of corrosion in silver is divided into three groups :—

(1) Tarnish—This can be removed by 90 parts of water and 10 parts of ammonia solution. After cleaning the specimen should be thoroughly washed and dried.

(2) Slight Corrosion—The specimen is to be placed in a porcelain pot and formic acid of 5% strength is poured into it and the pot is heated. The specimen is allowed to remain in the pot for an hour. After that it is taken out and cleaned with water and then immersed in ammonia solution. The solution is 20 parts ammonia and 80 parts water. After that the specimen is to be thoroughly dried.

(3) Considerable corrosion—In this case ammonia and water treatment is sufficient but the quantity should be of equal parts. When the object is cleaned thorough washing and drying should be taken into full consideration.

Gold

Golden specimens are not pure but contain small proportions of silver, copper, iron, etc. The chemical change is due to the presence of these metals which give rise to discolourisation or tarnish. For cleaning gold specimens washing with soap and warm water should be done aided by a cloth or soft brush. But if this treatment fails the next procedure is to apply 10 parts of ammonia and 90 parts of water with a small sponge. This will remove silver chloride which forms the tarnish.

Strong nitric acid removes the black stains on golden specimens. After nitric acid treatment the specimen should be washed well and then dilute ammonia solution and water should be applied.

Sometimes incrustations of calcium carbonate or calcium sulphate are found on old golden specimens. 10 parts of dilute hydrochloric acid and 90 parts of water remove the incrustations. But after soaking the specimen in the acid thorough washing in water should be done. The next step should be the application of dilute ammonia and water.

Gilt specimens should be cleaned in the same way as those of gold mentioned above. Lucas has cleaned gilt objects with warm dilute ammonia solution aided by a sponge.

Iron

Specimens of iron or iron along with other metals exhibit a great variety of problems both in the state of decay in which they come for treatment and in the treatment required to arrest further change. Those of iron, either cast, wrought or steel, corrode very rapidly in a damp atmosphere. It is also noticeable that iron corrodes more quickly on the sea coast due to the presence of salt. The corrosion may be checked by applying a few chemical reagents.

The ordinary rusts on iron are due to the following :—

(1) Common salt
(2) Carbon dioxide
(3) Moisture.

Rusts from iron can be cleaned by a wire-brush. Then electro-chemical method with zinc and sodium hydroxide (NaOH) should be applied on iron and after this cleaning with water and brushing should be done.

Pyruma putty is used on heavily rusted iron specimens. After being heated and dried it sets very hard. It must be applied in thin layers as thick patches do not seem to harden readily throughout. The use of kaolin (Al_2O, $2SiO$, $2H_2O$) or china clay made into a paste with sodium silicate (Na_2SiO_3) solution gives similar result.

The use of three-in-one oil gives satisfactory result. Iron is at first scraped with sand paper or a fine wire-brush and then smeared in three-in-one oil.

Durophene diluted with benzol or vinyl-acetate dissolved in toluene ($C_6H_5CH_3$) forms a suitable reagent.

Exclusion of moisture and air is successfully employed by the Department of Geology, Field Museum of Natural History, U.S.A., on iron specimens. The chemical used is Stanolax oil. The writer's observations on surgical instruments gave similar results.

Linseed oil is a good preservative. But it does not suit well on surgical instruments. In the Ethnographic Museum of the Department of Anthropology, Calcutta University, linseed oil is used on iron specimens. Lucas says 'Vaseline may be used but paraffin wax is better.'

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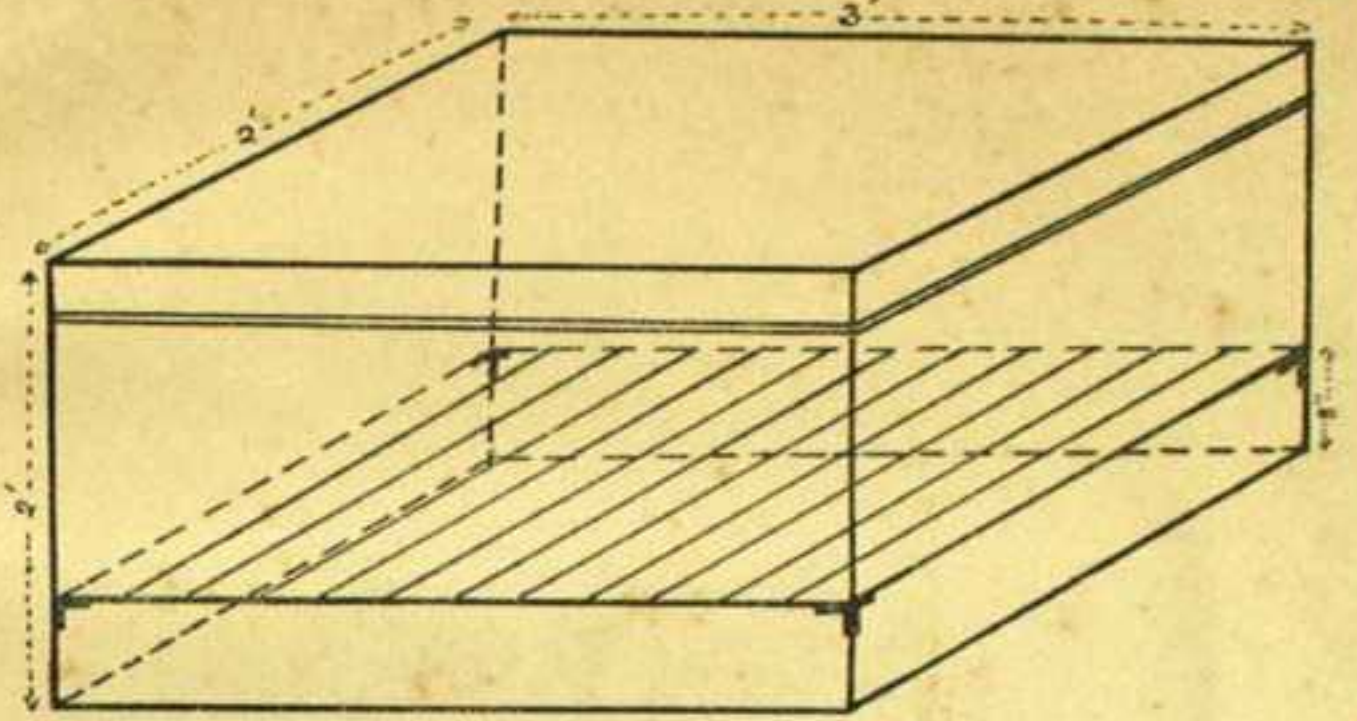

FIG. 1

Carbon-disulphide Chamber

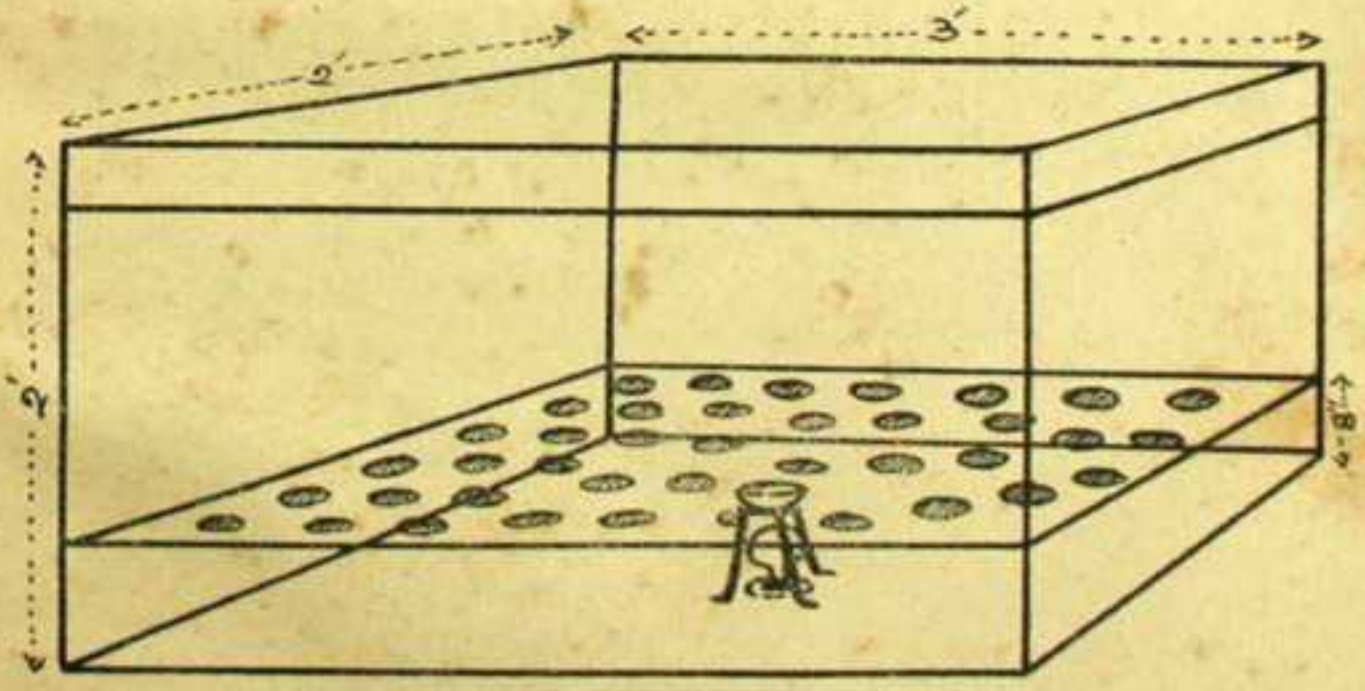

FIG. 2

Thymol Chamber

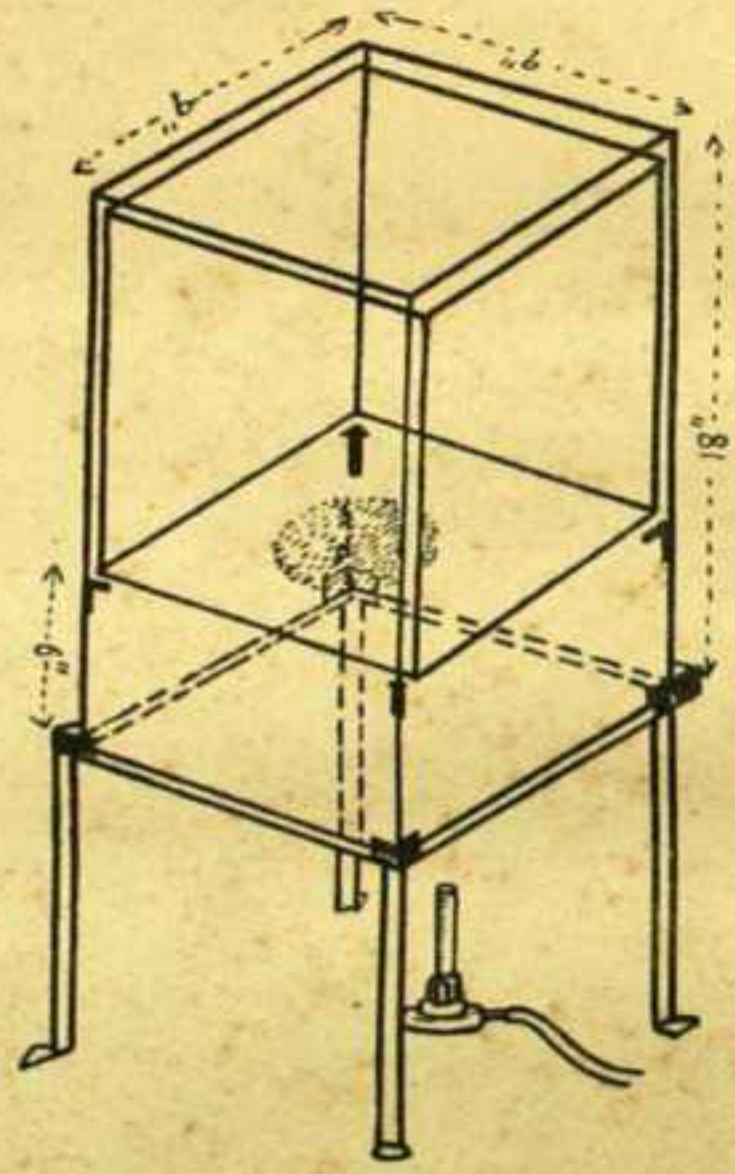

FIG. 3

Formaldehyde Chamber